(Candidates are allowed *additional 15 minutes* for only reading the paper.
They must **NOT** start writing during this time.)
This paper is divided into *four Sections — A, B, C and D.*
Answer all questions.
Section – A consists of *one question* having sub-parts of *one mark each.*
Section – B consists of *seven questions* of *two marks each.*
Section – C consists of *nine questions* of *three marks each,* and
Section – D consists of *three questions* of *five marks each.*
Internal choices have been provided in *two questions* each in *Section B,*
Section C and *Section D.*
The intended marks for questions are given in brackets [ ].
All working, including rough work, should be done on the same sheet as and adjacent
to the rest of the answer.
Answers to sub parts of the same question must be given in one place only. A list of useful
physical constants is given at the end of this paper.
A simple scientific calculator without a programmable memory may be used for calculations.

SECTION A — 14 MARKS

Question 1

(A)   In questions (i) to (vii) below, choose the correct alternative (a), (b), (c) or (d) for
each of the questions given below:

(i)   What is the unit of solid angle?   [1]
    (a)   second
    (b)   steradian
    (c)   kilogram
    (d)   candela

(ii)   In equation $v = at + b$, v is velocity and t is time. The dimensional formula
of a/b will be :   [1]
    (a) $[M^0LT^{-1}]$
    (b) $[M^0L^0T^{-1}]$
    (c) $[M^0L^{-1}T^{-1}]$
    (d) $[M^0L^{-1}T]$

(iii)   **Assertion :** On a rainy day, it is difficult to drive a car or bus at high
speed.
    Reason : The value of coefficient of friction is lowered due to wetting
of the surface.   [1]
    (a)   Both Assertion and Reason are correct, and Reason is the correct
explanation for Assertion.
    (b)   Both Assertion and Reason are correct, but Reason is not the
correct explanation for Assertion.
    (c)   Assertion is true and Reason is false.
    (d)   Assertion is false and Reason is true.

(iv)   The density of a material in SI units is 128 kg m⁻³. In a new system of
units in which the unit of length is 25 cm and the unit of mass is 50 g,
the numerical value of density of the material is :   [1]
    (a)   40
    (b)   16
    (c)   640
    (d)   410

(v)   Forces acting for a short duration are called as _____   [1]
    (a)   Short force
    (b)   Interval force
    (c)   Impulsive forces
    (d)   Interrupting force

SECTION C – 27 MARKS

Question 9 [3]

Find area of parallelogram formed by the vectors $\vec{A} = 4\hat{i} + 5\hat{j} + 2\hat{k}$ and $\vec{B} = 6\hat{i} - 4\hat{j} + 3\hat{k}$

Question 10 [3]

(i) What is angle of repose ? Establish the relationship between angle of repose and angle of friction.

OR

(ii) Show that the path of a projectile is a parabola.

Question 11 [3]

A projectile is given an initial velocity of $(\hat{i} + 2\hat{j})$ m/s where $\hat{i}$ is along the ground and $\hat{j}$ is along the vertical upward. If g = 10 m/s², then find equation of its trajectory.

Question 12 [3]

(i) State the laws of limiting friction.

OR

(ii) A fireman of mass 80 kg slides down a pole during a rescue mission. The force of friction is constant at 720 N. Find acceleration of the man. (g = 10 m/s²)

Question 13 [3]

Three blocks with masses m, 2m and 3m are connected by light strings, as shown in the figure. After an upward force F is applied on block m, the masses move upward at constant speed v. What are the values of tensions in strings P and Q. (g is the acceleration due to gravity)
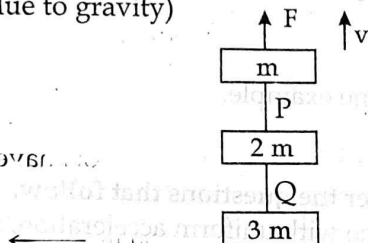
Question 14 [3]

The resultant of two vectors $\overline{A}$ and $\overline{B}$ is perpendicular to the vector $\overline{A}$ and its magnitude is equal to half of the magnitude of the vector $\overline{B}$. Find out the angle between $\overline{A}$ and $\overline{B}$.

Question 15 [3]

A car accelerates from rest at a constant rate 'α' for some time, after this it de-accelerates at a constant rate β and comes to rest. If the total time elapsed is t second, then calculate:

(i) Maximum velocity attained by the car.
(ii) Total distance travelled by car in terms of α , β and t.

Question 16 [3]

Initial velocity of a body moving along a straight path is 9 m/s. A retardation of 2 m/s² acts on it. Find :

i) Displacement of the body after 5 seconds.
ii) Distance travelled by the body in 5 second.
iii) Distance travelled by the body in 5ᵗʰ second.

Question 17 [3]

Derive formula for the centripetal acceleration required for the circular motion of a particle.

SECTION D – 15 MARKS

Question 18 [3+2=5]

(a) Find (i) time of flight, (ii) Max. height and (iii) horizontal range of a projectile projected with speed u making an angle θ with the horizontal direction from ground.

(b) Prove that the impulse received during an impact is equal to the total change in momentum produced during the impact.

OR

(a)   If $\vec{A} = 2\hat{i} + 3\hat{j} + 5\hat{k}$ and $\vec{B} = 3\hat{i} - 2\hat{j} + 2\hat{k}$

Find (i) $\vec{A} \cdot \vec{B}$ (ii) Angle between $\vec{A}$ and $\vec{B}$

(b)   The motion of a car along yaxis is given by $v = -12t + 12$ where velocity v is in m/s and time t is in second. Find the instantaneous position of the car as a function of time if at t = 0, it was at 5 m. Also find its acceleration at any instant.
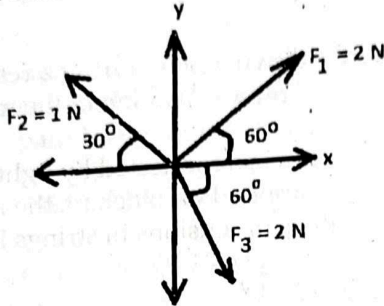
[2+3=5]

Question 19

(a)   State and prove law of conservation of momentum.

(b)   A bomb of mass M at rest explodes in to three pieces, two of which of mass $M/4$ each, fly off in perpendicular directions with velocities of 3 m/s and 4 m/s respectively. Find the magnitude of velocity of third piece.

OR

(a)   Find magnitude of resultant of forces $\vec{F}_1$, $\vec{F}_2$ and $\vec{F}_3$ as shown in figure. [3+2=5]

(b)   Define centripetal force and give one example.

Question 20

Read the passage given below and answer the questions that follow.

When an object moves along a straight line with uniform acceleration, it is possible to relate its velocity, acceleration during motion and the displacement in a certain time interval by a set of equations known as the equations of motion. For convenience, a set of three such equations are given below :

$v = u + at$ \qquad $S = ut + 1/2 \, at^2$ \qquad $2aS = v^2 - u^2$

Where u is the initial velocity of the object which moves with uniform acceleration 'a' for time t, v is the final velocity and S is the displacement of the object in time t.

1)   Under what condition equations of motion are applicable ? [1]
2)   There are 4 equations of motion. True or false? [1]
3)   The brakes applied to a car produce an acceleration of 10 m/s² in the opposite direction to the motion. If the car takes 1 s to stop after the application of brakes, calculate the distance traveled during this time by car. [2]
4)   An object, dropped from a tower, falls with a constant acceleration of 10 m/s². Find its speed 10 s after it was dropped. [1]

Useful Constants & Relations :

S. No.		
1	Acceleration due to gravity	$9.8 \, \text{ms}^{-2}$

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